New Methods for Approaching OT&E MOEs and MOPs

Automated Generation of Measures of Effectiveness/Performance for Correlation in C4I Systems

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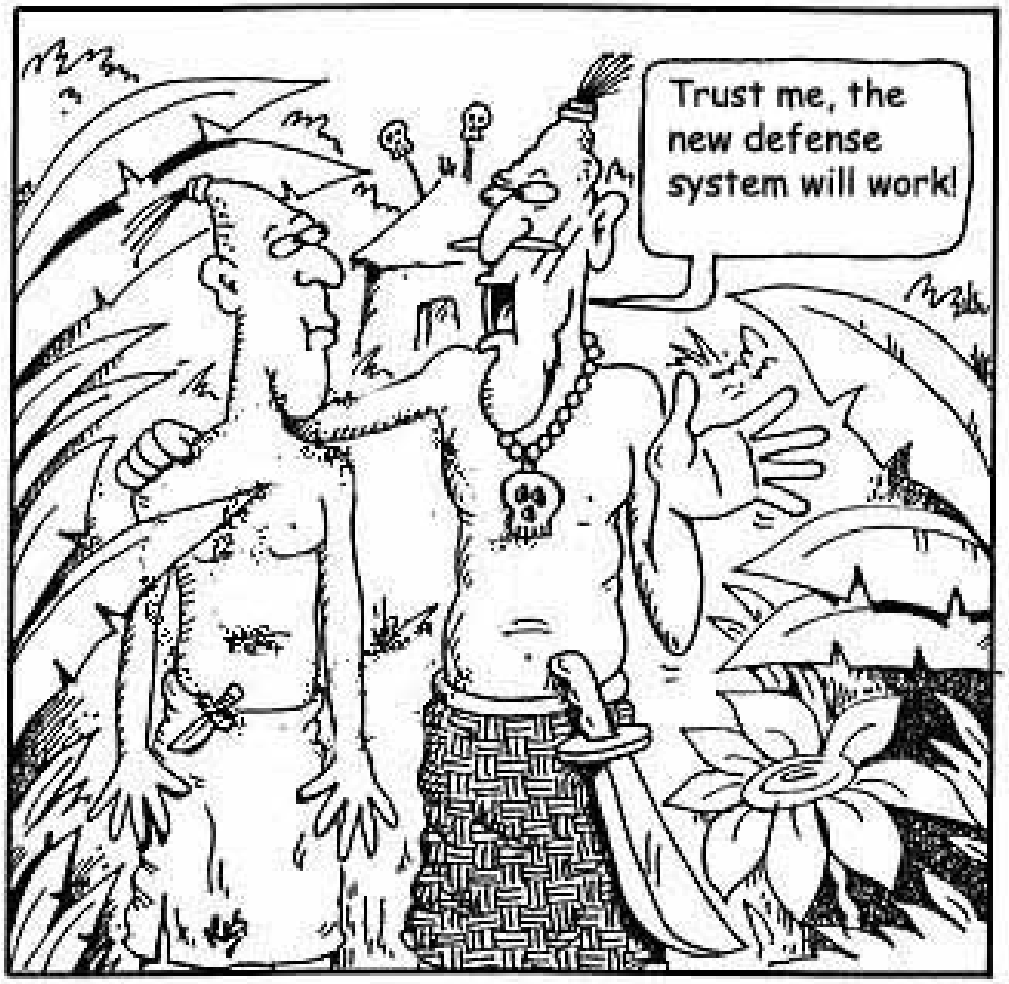
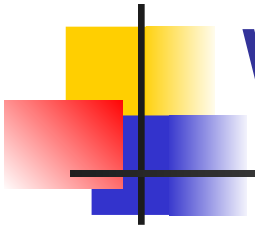
Ghana, 16 March 2001



Ghana Defense Systems Head of R&D

Who We Are

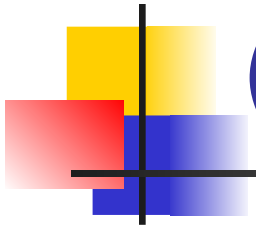
- Syzygy Technologies, Inc.
  - Full service IT company: T&E, Software Development, Networking, Security, Integration
  - One of the premier C4I T&E companies for the United States Navy: GCCS, Gale, TBMCS
  - Syzygy's S/W Developers created Automated Test Tools (ATT) for use by our testers:
    - DII COE Compliancy
    - Message Capture, Generation and Playback
    - MOE & MOP for Correlation



Why Automated Testing?

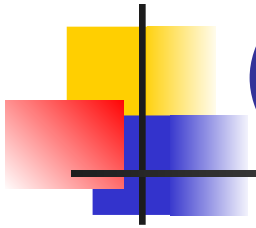
- Key Tenets for Successful Testing: Tests must be:
  - Definable
  - Measurable
  - Consistent
  - Objective
- If tests lack in any of these qualities, they may not be repeatable and therefore of much less value

Why Automated Testing? (cont'd)



- The human factor = the weak link
  - ATT minimizes human error
- Data collection = tedium & inconsistency
  - ATT automatically collects results
- Subject Matter Expertise is Rare = inconsistent long-term test conduct
  - ATT preserves domain expertise in code

Why Automated Testing? (cont'd)



- Determining if the "system is getting better" is subjective = upset users
  - ATT can generate quantitative metrics
- Development slips to the right; deliverable deadlines rarely slip = little time to test
  - ATT can save time

The Correlation Problem

- Correlators are basic to an effective C4I system
- What is the effectiveness of correlation algorithms and systems?
- Manual data collection and analysis typifies the flaws of the human factor
- A faulty correlator could mean faulty command decisions

Defining the Process

- Correlation Testing Process was outlined by SPAWAR Systems Center, San Diego
- Published as Technical Report 1475, *Naval Tactical Command Systems Afloat (NTCSA) Correlator/Tracker Evaluation*, 1991
- Defines a number of MOE/MOPs to be used for evaluating correlation effectiveness
- This paper provided a solid basis for conducting correlation evaluation

Defines the Metrics

- Consistent Correlation
- Correct Correlation
- Total Fragmentation
- Track Fragmentation
- Miscorrelation
- Ambiguities
- Constructed Track Ratio
- Track Purity
- Track Continuity
- Track Fidelity

Executing the Process was Difficult

INPUT

```
ZNR UUUUU
R 010001Z APR 97
FM TABULAR
TO GOLD
BT
UNCLASSIFIED
MSGID/TABULAR/GOLD/0014/APR
CTC/T7777/UNEQUATED-UNKNOWN//////AL//HIT/00//////
POS/190101Z1/APR/4000N4/08000W8//72.0T/7.3NM/4.1NM//////JM
RADB/190101Z1/APR/B999A//4000.000MHZ/1000.4060//3.310/6.300/Z
POS/190102Z1/APR/4000N4/08000W8//72.0T/7.3NM/4.1NM//////JM
RADB/190102Z1/APR/B999A//4000.000MHZ/1000.4060//3.310/6.300/Z
POS/190103Z1/APR/4000N4/08000W8//72.0T/7.3NM/4.1NM//////JM
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POS/190107Z1/APR/4000N4/08000W8//72.0T/7.3NM/4.1NM//////JM
RADB/190107Z1/APR/B999A//4000.000MHZ/1000.4060//3.310/6.300/Z
ENDAT/OADR
BT
```

OUTPUT

```
ZNR UUUUU
R 010001Z APR 97
FM TABULAR
TO GOLD
BT
UNCLASSIFIED
MSGID/TABULAR/GOLD/0014/APR
CTC/X7777/UNEQUATED-UNKNOWN//////AL//HIT/00//////
POS/190101Z1/APR/4000N4/08000W8//72.0T/7.2NM/4.1NM//////JM
RADB/190101Z1/APR/B999A//4000.000MHZ/1000.4060//3.310/6.300/Z
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RADB/190102Z1/APR/B999A//4000.000MHZ/1000.4060//3.310/6.300/Z
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RADB/190107Z1/APR/B999A//4000.000MHZ/1000.4060//3.310/6.300/Z
ENDAT/OADR
BT/Z
```
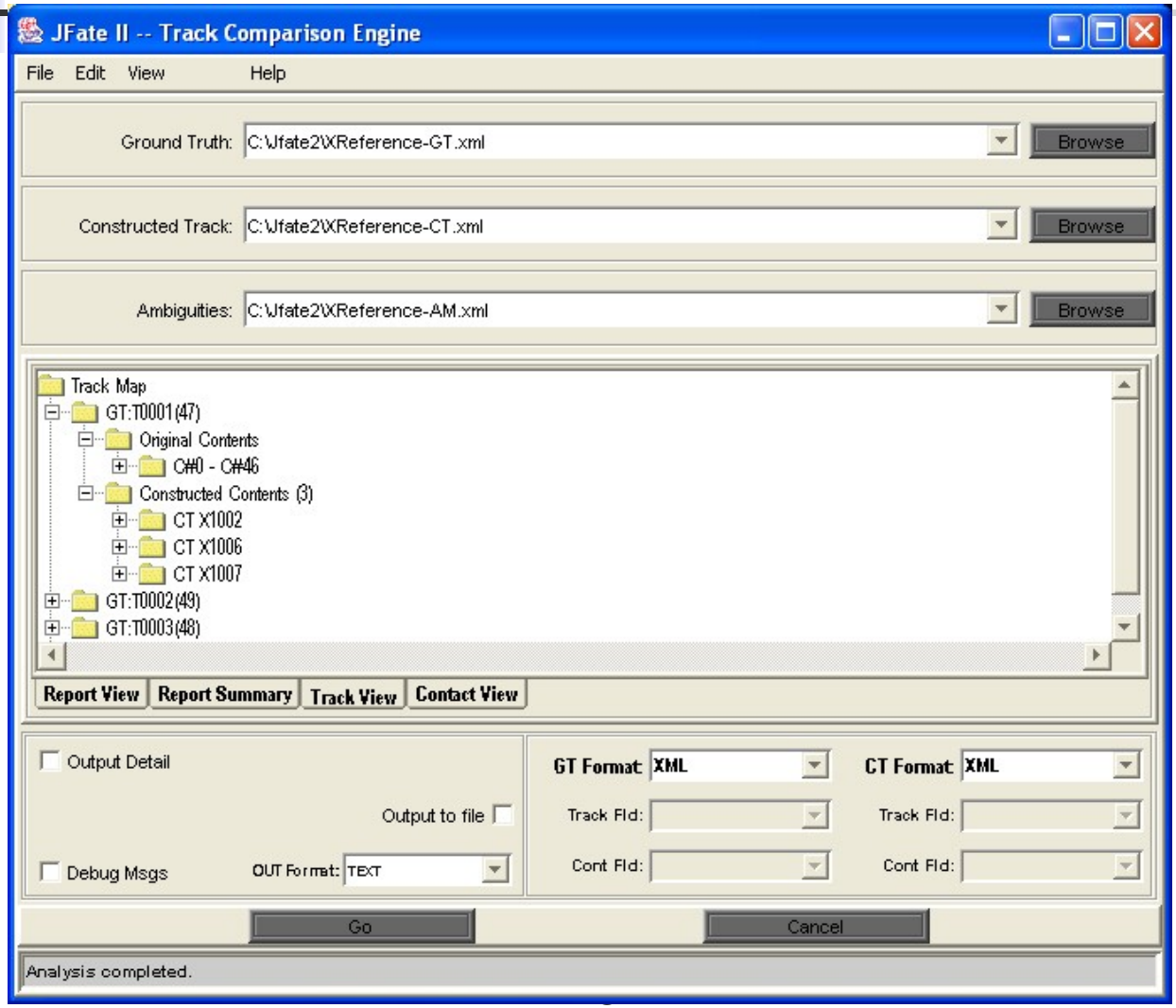

JFATE is Born

- The Joint Fleet Automated Track Evaluator automates the process of evaluating correlation results
- Provides a friendly graphical interface to conduct the test and view the results
- Runs on multiple platforms: HP, Sun, Windows, Linux, etc.
- Provides consistent execution of TR 1475 correlation testing making it quick and easy

JFATE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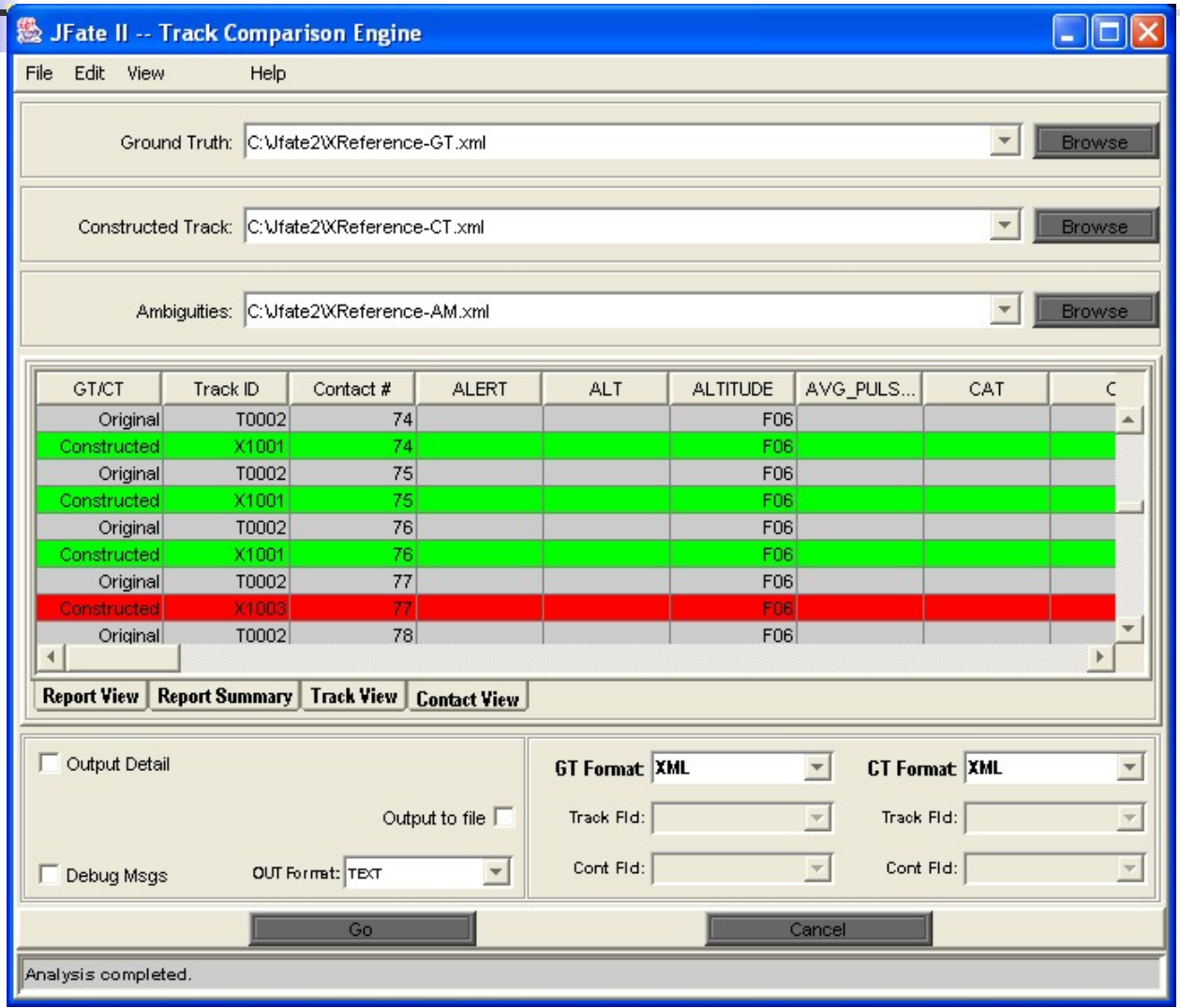
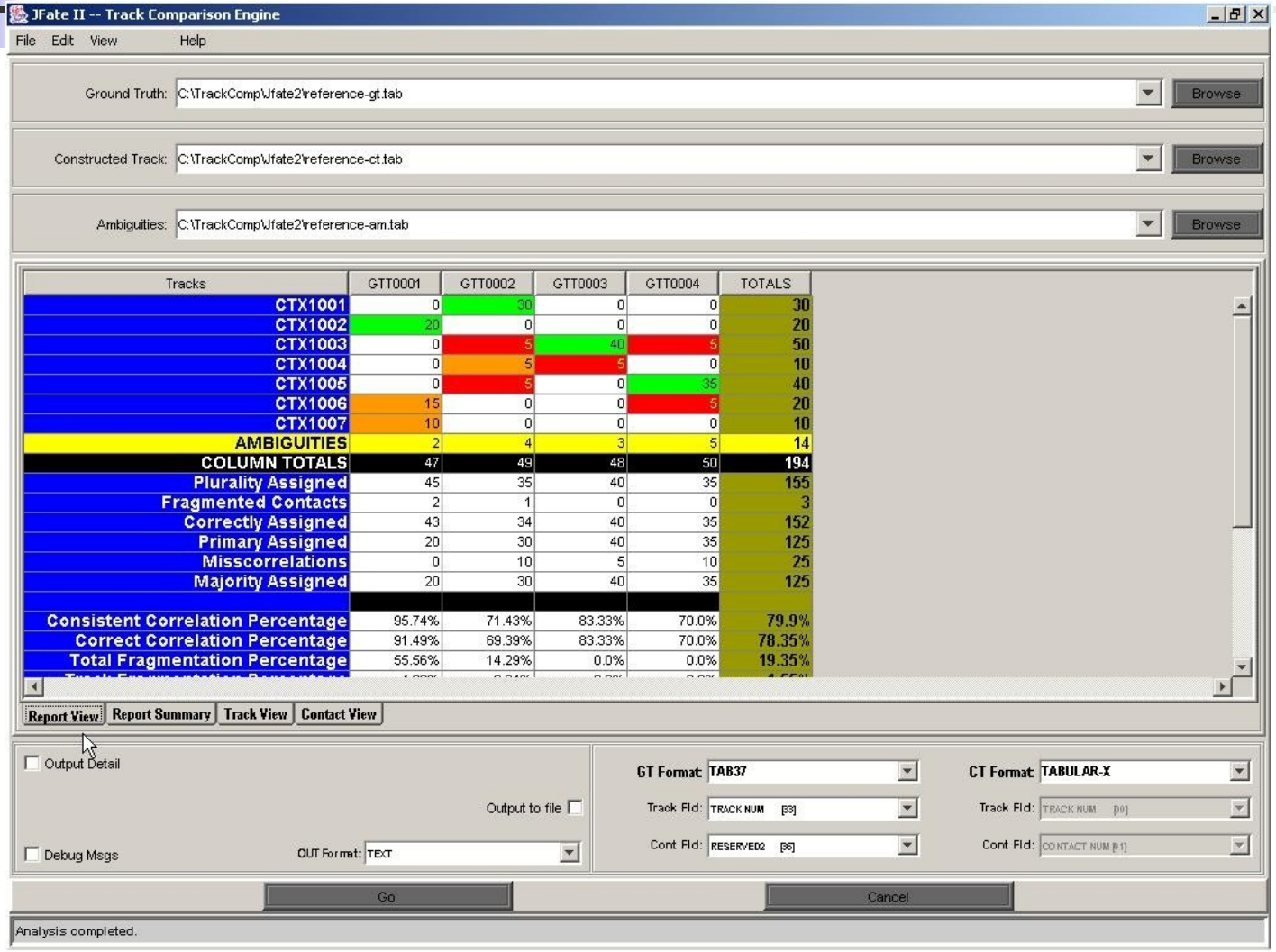
Ground Truth: C:\Jfate2\XReference-GT.xml Browse
Constructed Track: C:\Jfate2\XReference-CT.xml Browse
Ambiguities: C:\Jfate2\XReference-AM.xml Browse
Track Map
GT:T0001(47)
Original Contents
C#0 - C#46
Constructed Contents (3)
CT X1002
CT X1006
CT X1007
GT:T0002(49)
GT:T0003(48)
Report View
Report Summary
Track View
Contact View
Output Detail
Output to file
Debug Msgs
OUT Format: TEXT
GT Format: XML
CT Format: XML
Track Fld:
Cont Fld:
Track Fld:
Cont Fld:
Go
Cancel
Analysis completed.

JFATE

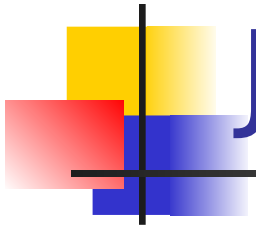

JFate II -- Track Comparison Engine
File Edit View Help
Ground Truth: C:\Jfate2\XReference-GT.xml Browse
Constructed Track: C:\Jfate2\XReference-CT.xml Browse
Ambiguities: C:\Jfate2\XReference-AM.xml Browse
GT/CT Track ID Contact # ALERT ALT ALTITUDE AVG_PULS... CAT C
Original T0002 74 F06
Constructed X1001 74 F06
Original T0002 75 F06
Constructed X1001 75 F06
Original T0002 76 F06
Constructed X1001 76 F06
Original T0002 77 F06
Constructed X1003 77 F06
Original T0002 78 F06
Report View Report Summary Track View Contact View
Output Detail
Output to file
Debug Msgs
OUT Format: TEXT
GT Format: XML
Track Fld:
Cont Fld:
CT Format: XML
Track Fld:
Cont Fld:
Go
Cancel
Analysis completed.

JFATE


JFate II -- Track Comparison Engine
File Edit View Help
Ground Truth: C:\TrackComp\Jfate2\reference-gt.tab
Browse
Constructed Track: C:\TrackComp\Jfate2\reference-ct.tab
Browse
Ambiguities: C:\TrackComp\Jfate2\reference-am.tab
Browse
Tracks GTT0001 GTT0002 GTT0003 GTT0004 TOTALS
CTX1001 0 30 0 0 30
CTX1002 20 0 0 0 20
CTX1003 0 5 40 5 50
CTX1004 0 5 5 0 10
CTX1005 0 5 0 35 40
CTX1006 15 0 0 5 20
CTX1007 10 0 0 0 10
AMBIGUITIES 2 4 3 5 14
COLUMN TOTALS 47 49 48 50 194
Plurality Assigned 45 35 40 35 155
Fragmented Contacts 2 1 0 0 3
Correctly Assigned 43 34 40 35 152
Primary Assigned 20 30 40 35 125
Misscorrelations 0 10 5 10 25
Majority Assigned 20 30 40 35 125
Consistent Correlation Percentage 95.74% 71.43% 83.33% 70.0% 79.9%
Correct Correlation Percentage 91.49% 69.39% 83.33% 70.0% 78.35%
Total Fragmentation Percentage 55.56% 14.29% 0.0% 0.0% 19.35%
Report View
Report Summary
Track View
Contact View
Output Detail
Output to file
Debug Msgs
OUT Format: TEXT
GT Format: TAB37
Track Fld: TRACK NUM [83]
Cont Fld: RESERVED2 [86]
CT Format: TABULAR-X
Track Fld: TRACK NUM [00]
Cont Fld: CONTACT NUM [01]
Go
Cancel
Analysis completed.

MOE/MOP: Makes it Easy to Compare Software Performance

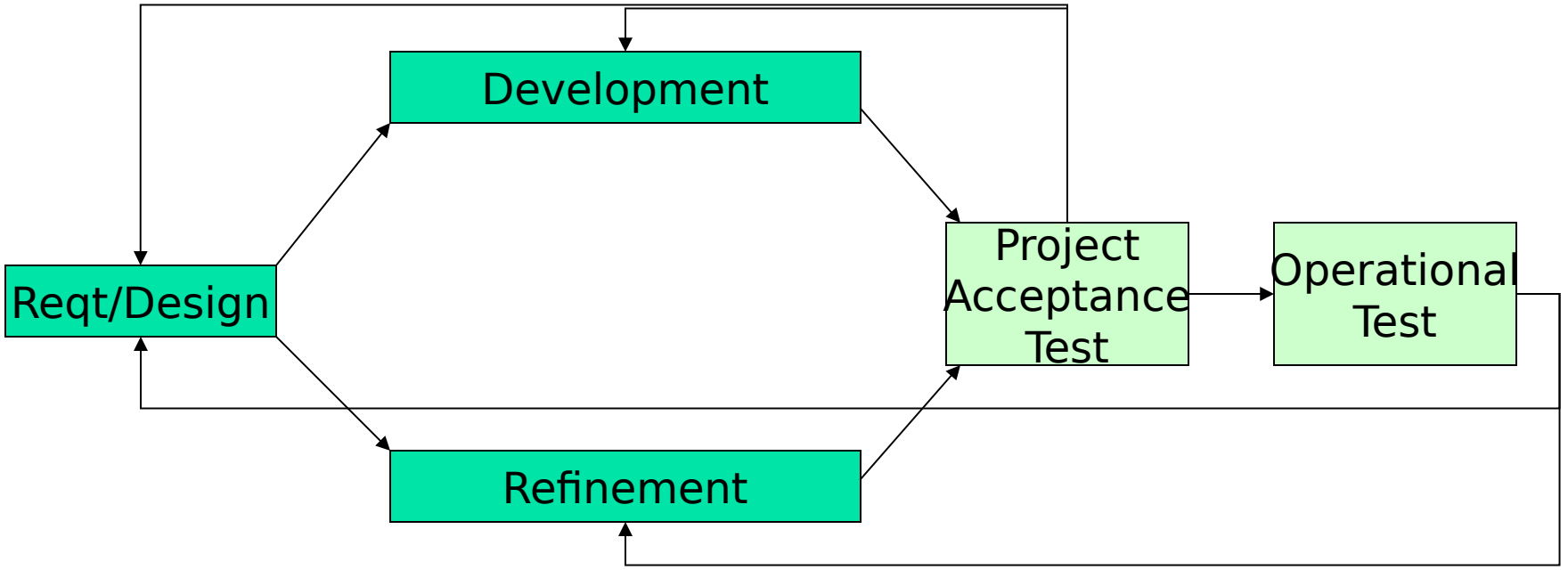
	System A	System B	System C	System D
Track/Contact Counts				
GT Tracks (Platform/Emitter)	18/21	18/21	18/21	18/21
Constructed Tracks	89	213	38	33
Contacts Submitted/Processed	354/354	354/310	354/340	354/354
Contacts Not Processed/Filtered	0	44	14	0
% Contacts Not Processed	0	12.43	4.11	0
MOE				
Consistent Correlation	90.11	84.52	91.47	90.96
Correct Correlation	70.06	21.61	85.59	86.72
Total Fragmentation	45.77	83.59	18.01	12.11
Track Fragmentation	20.06	62.9	5.88	4.24
Miscorrelation	4.24	1.29	8.53	7.91
Ambiguity	5.65	14.19	0	1.13
C/T Ratio	4.94	11.83	2.11	1.83
Overall Track Purity	95.51	98.5	91.47	92
Overall Track Continuity	48.87	13.87	75	79.94
Track Fidelity	0.4857	0.2523	0.6801	0.7292
TEMP Index	1.1986	1.8563	0.7557	0.6786



JFATE Advantages

- Running a test in minutes rather than days
- “Expertise” is built-in/preserved
- Results are objective
- Metrics can help the decision making process

Test Tools in the Dev Cycle



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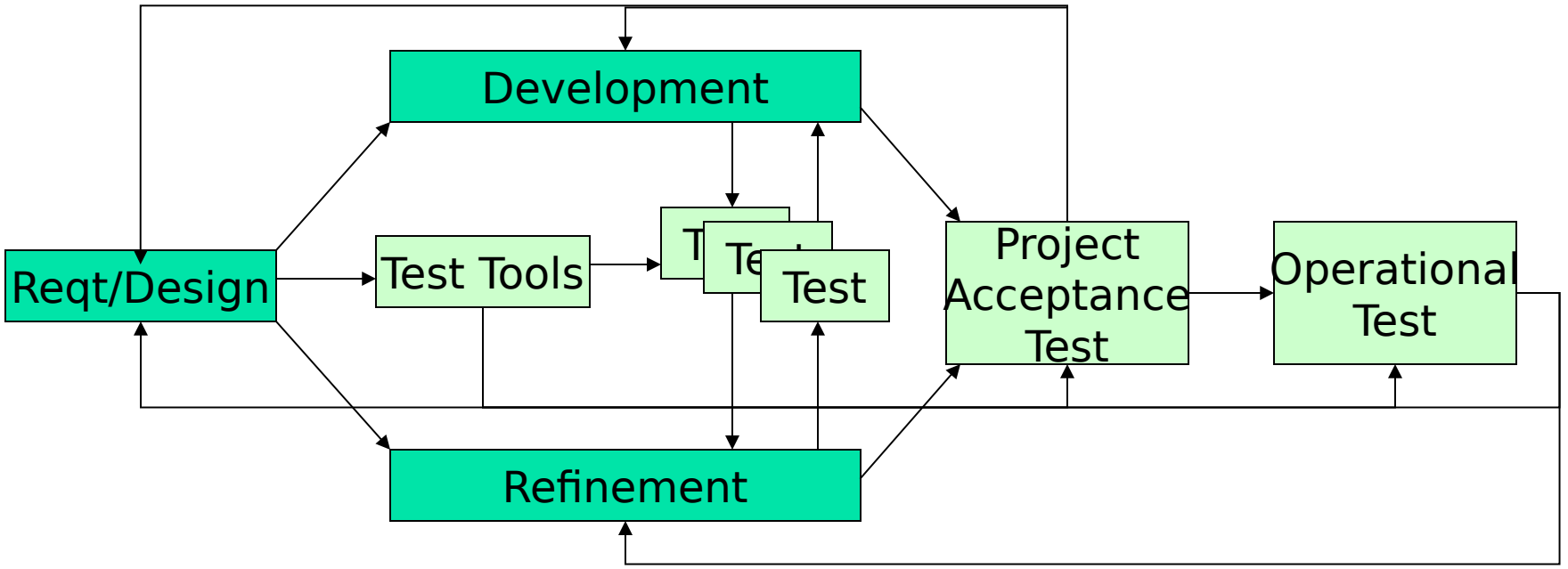
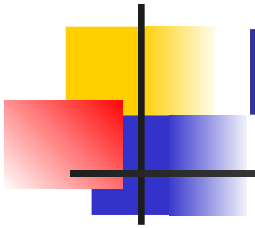
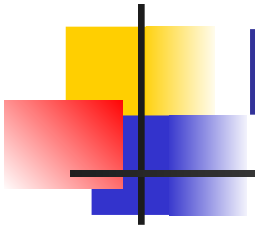




Points to Consider

- Evaluation is programmatic: we will only catch errors that the tool is designed to catch.
- Requirements vary: the tools need to be tweaked accordingly
- Developing a tool is expensive: the ability to build on existing tools saves on cost – and the cost is mitigated by the savings in time/resources during the test phases of a project



For More Information

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